The Intermountain Region Air Resource Division Air Quality Summary

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The Integration of Air Quality with Monitoring

Air pollution damages resources and values that national parks have been set aside to protect. The National Park Service (NPS) has responsibility to remedy and prevent damage to air quality and related values. Comprehensive scientific information is essential to understand and document air quality conditions and effects of air pollution on park resources. More than ten years of monitoring in several parks shows that air pollution is degrading visibility, injuring vegetation, changing water and soil chemistry, contaminating fish and wildlife, and endangering visitor and employee health. Information generated through the existing network of NPS air quality monitoring stations and related research programs has been used by NPS managers to secure substantial pollution reductions at specific industrial facilities, to persuade States to limit emissions from new pollution sources, and to bolster the U.S. Environmental Protection Agency's (EPA) promulgation of more stringent air pollution regulations.

Under the Clean Air Act (42 USC 7401-7671q, as amended in 1990), park managers have a responsibility to protect air quality and related values from the adverse effects of air pollution. Protection of air quality in national parks requires knowledge about the origin, transport, and fate of air pollution, as well as its impacts on resources. To be effective advocates for the protection of park air resources, the CHDN needs to know the air pollutants of concern, existing levels of air pollutants in parks, park resources at risk, and the potential or actual impact on these resources. Through previous monitoring our network has obtained some current status of the air quality of our park units (Figure 7). Nevertheless, future plans and projects need to be set up for continuous monitoring. Air quality was identified as potential vital sign for the network because of its importance as both an anthropogenic and natural driver of change.

Currently, our network has three park units (Big Bend NP, Carlsbad Caverns NP, Guadalupe Mountains NP) designated as Class 1 air quality units under the Clean Air Act. The other units are designated as Class 2 air quality units. Class 1 units receive the highest protection under the Clean Air Act. Air quality and related information for the network is at http://www2.nature.nps.gov/air/Permits/ARIS/networks/index.htm.

The park units in the network are affected by both near and distant sources of air pollution, including power plants and industry and, more recently, increasing oil and gas development. These air pollutants affect, or have the potential to affect, air quality and natural resources in CHDN, including vegetation, wildlife, soils, water quality, and visibility. High levels of ozone in the area, for example, may affect vegetation, as well as the health of park visitors and staff. Nitrogen compounds from the atmosphere have the potential to affect water quality and biota, soil nutrient cycling and plant species composition. Pollutant particles in the air reduce visibility in the region and affect how far and how well we can see. Atmospheric deposition of toxic organic compounds and metals, including mercury, may have a wide range of effects on fish and wildlife. The following sections describe air pollutant emissions, air quality monitoring, and air pollutant concerns for resources in the network.

Air Pollutant Emissions

Air quality in the network is affected primarily by air pollution sources in Texas, New Mexico, and Mexico, although more distant sources can also affect the area's air quality. Air pollutant emissions come from a variety of sources, including mobile sources (e.g., cars, trucks, off-road vehicles), stationary sources (e.g., power plants and industry), and area sources (e.g., oil and gas development, agriculture, fires, and road dust).

Some of the most common and abundant pollutant emissions include nitrogen oxides, ammonia, and sulfur dioxide. Figure 1 shows distribution maps for emissions of nitrogen oxides, ammonia, and sulfur dioxide in Texas and New Mexico. Similar maps are not available for Mexico, but information on air pollution sources in Mexico has been compiled for the Big Bend Regional Aerosol & Visibility Observational Study (BRAVO) Emissions Inventory and is available at http://www.epa.gov/ttn/chief/net/mexico.html.

Major sources of nitrogen oxides include cars and other mobile sources, industrial engines and compressors, power plants and industry. Agricultural activities are the main sources of ammonia. The major sources of sulfur dioxide are coal-burning power plants, industry, and diesel engines. Additional information on pollutant sources in the U.S. can be found at http://www.epa.gov/air/data/index.html.

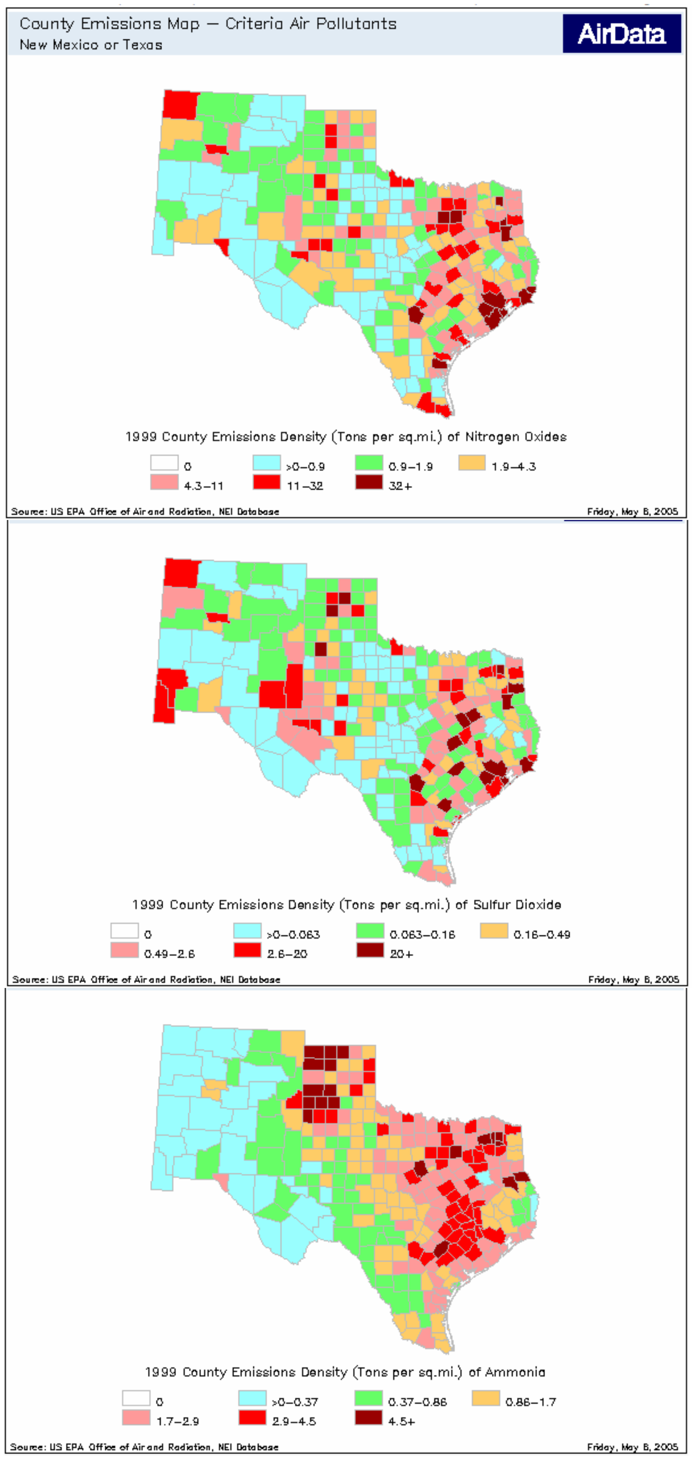

Figure 1. Density of air pollutant emissions in 1999 of nitrogen oxides, ammonia, and sulfur dioxide, by county, in Texas and New Mexico. Emissions are given in thousands of tons per year for nitrogen oxides and sulfur dioxide and tons per year for ammonia (from EPA AirData at http://www.epa.gov/air/data/index.html).

The maps in figure 1 are based on the 1999 emissions inventory from the Environmental Protection Agency (EPA) and do not include emissions from more recent oil and gas development in the region. In particular, there is tremendous pressure to develop oil and gas in southeastern New Mexico, including areas adjacent to Carlsbad Caverns NP.

Air Quality Monitoring and Effects

Figure 2 shows current air quality monitoring in or near CHDN park units. Table 1 lists air quality monitoring site locations. Big Bend NP and Guadalupe Mountains NP have on-site air quality monitoring. Types of monitoring include ozone monitoring by States (Ozone) and by NPS (GPMN – Gaseous Pollutant Monitoring Network for ozone); wet deposition (rain, snow) monitoring of atmospheric pollutants by the National Atmospheric Deposition Program/National Trends Network (NADP/NTN); wet deposition monitoring of mercury by the Mercury Deposition Network (MDN); dry deposition (dryfall) monitoring of atmospheric pollutants by the Clean Air Status and Trends Network (CASTNet); and visibility monitoring by the Interagency Monitoring of Protected Visual Environments (IMPROVE) Program.

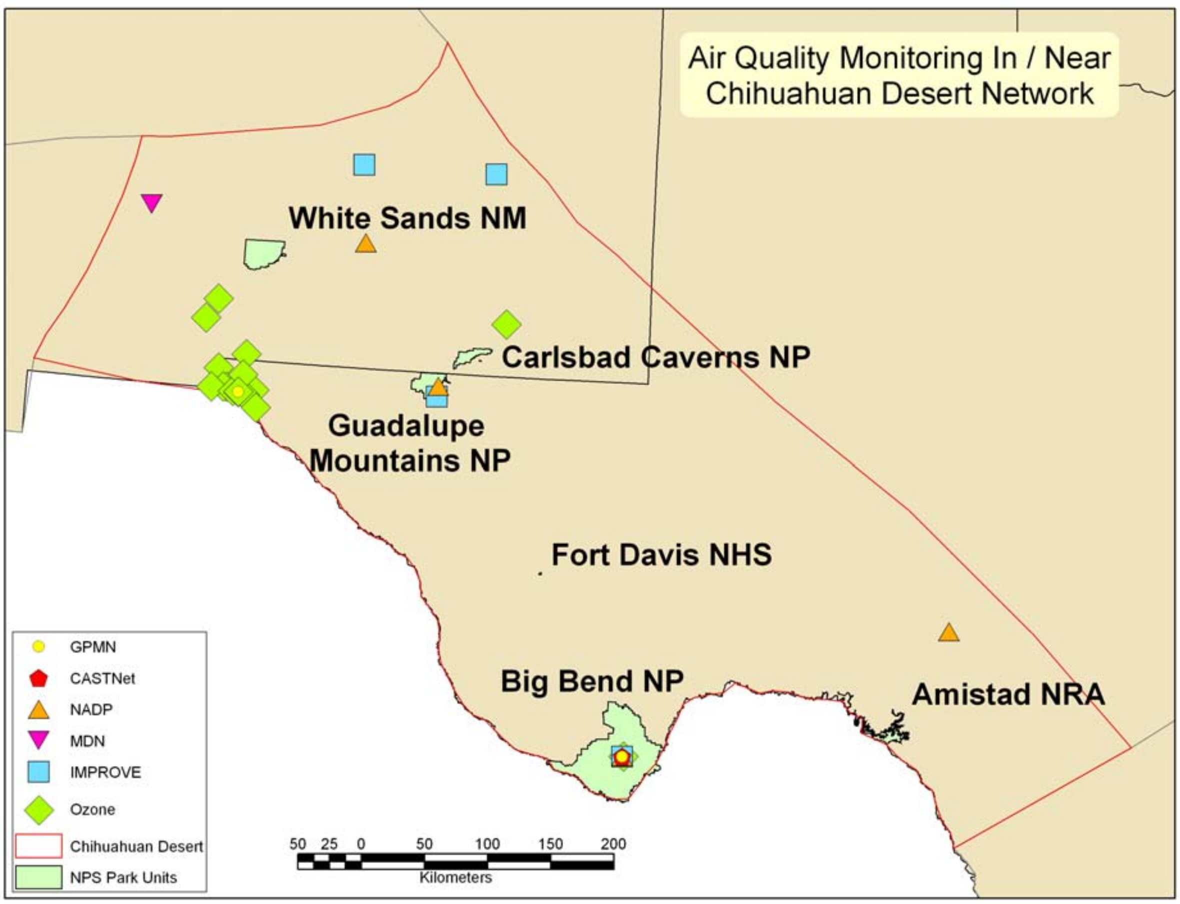

Figure 2. Air quality monitoring in CHDN (GPMN=NPS Gaseous Pollutant Monitoring Network; CASTNet= Clean Air Status and Trends Network; NADP= National Atmospheric Deposition Program; MDN=Mercury Deposition Network; IMPROVE=Interagency Monitoring of Protected Visual Environments; Ozone=ozone monitoring by States. Not pictured on the map is NDAMN (National Dioxin Air Monitoring Network) at Big Bend NP.)

Table 1. Current air quality monitoring sites in or near NPS units in CHDN. Air quality data is available from the monitoring network websites listed below. Data from distant monitors are unlikely to be representative of conditions in a park unit; Air Atlas estimates should be used in these cases. Air quality estimates for CHDN park units are available from NPS Air Atlas at http://www2.nature.nps.gov/air/Maps/AirAtlas/index.htm.

MONITORING NETWORK	SITE I.D.	LOCATION
GPMN Ozone	Big Bend Chamizal	Brewster County, TX El Paso County, TX
CASTNet	BBE401 (Big Bend)	Brewster County, TX
NADP	TX04 (Big Bend) TX22 (Guadalupe Mountains) TX16 (Sonora) NM08 (Mayhill)	Brewster County, TX Culberson County, TX Edwards County, TX Otero County, NM
MDN	NM10 (Caballo)	Sierra County, NM
IMPROVE	BIBE1 (Big Bend) GUMO1 (Guadalupe Mountains) SACR1 (Salt Creek – Bitter Lake NWR) WHIT1 (White Mountain - USFS)	Brewster County, TX Culberson County, TX Chaves County, NM Lincoln County, NM
Ozone	various	There are a number of ozone monitors located near El Paso, (TX), Las Cruces (NM), and Carlsbad (NM)
NDAMN	Big Bend	Brewster County, TX

NADP/NTN = National Atmospheric Deposition Program at http://nadp.sws.uiuc.edu/
MDN = Mercury Deposition Network at http://nadp.sws.uiuc.edu/mdn/
CASTNet = Clean Air Status and Trends Network at http://www.epa.gov/castnet/
IMPROVE = Interagency Monitoring of Protected Visual Environments at http://vista.cira.colostate.edu/views/
GPMN = Gaseous Pollutant Monitoring Network at NPS AirWeb at http://www2.nature.nps.gov/air/data/index.htm
Ozone = EPA AirData at http://www.epa.gov/air/data/index.html
NDAMN = National Dioxin Air Monitoring Network at http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=54811.

Air Quality Estimates: Air Atlas

NPS Air Resources Division has developed Air Atlas to provide estimates of air quality conditions for park units without on-site monitoring (http://www2.nature.nps.gov/air/Maps/AirAtlas/index.htm). Air Atlas serves as the air inventory for parks and is a mini-GIS tool that provides national maps and an associated look-up table with baseline values of air quality parameters for all Inventory and Monitoring (I&M) parks in the U.S. The values are based on 1995-1999 data. An update with 1999-2003 data will be available in summer 2005.

The estimated air quality values provided in Air Atlas are based on the center of the polygon defining the park or multiple units of the park. Data from all available monitors operated by NPS, States, EPA, and other programs are used for the interpolation of the air quality values. Air Atlas contains a comprehensive set of air quality parameters. Table 2 summarizes selected air quality parameters for CHDN.

Table 2. Estimates of selected air quality parameters for units of the CHDN (from Air Atlas at http://www2.nature.nps.gov/air/Maps/AirAtlas/index.htm).

CHIHUAHUAN DESERT NETWORK		Ozone					NADP (kg/ha/yr)		Visibility - IMPROVE	
PARK	CLASS	2ndHi1hr	4thHi8hr	#8hr>85	#1hr>100	Sum06_3Mo	Total S	Total N	b_{ext}Clear	b_{ext}Hazy
Amistad NRA	2	108.7	80.4	5.0	11.8	12.6	1.88	2.15	11	50
Big Bend NP	1	95.5	71.0	1.0	3.3	8.0	1.16	1.38	12	55
Carlsbad Caverns NP	1	104.5	72.2	1.0	4.3	14.0	1.25	1.54	11	43
Fort Davis NHS	2	103.8	72.7	1.2	4.6	10.9	1.16	1.45	11	46
Guadalupe Mountains NP	1	105.0	72.4	1.0	4.4	14.0	1.25	1.53	11	43
White Sands NM	2	102.1	71.7	0.9	3.7	13.8	1.09	1.44	9	35

Class: refers to an area's designation under the Clean Air Act
Ozone information represents 5-yr average of annual values from 1995-1999
2nd High 1 hr concentration (ppb): indicates peak values for ozone; old standard of 0.12 ppm (120 ppb) was based on 2nd hi,1-hr average
4th high 8 hr concentration (ppb): new ozone standard of 0.08 ppm (80 ppb) is based on 4th hi, 8-hr average
#8 hours>85 ppb: indicates how often the area would be in violation of the new 8-hr standard of 0.08 ppb
hours> 100 ppb: high peaks in ozone concentration, as well as cumulative dose, contribute to vegetation injury
SUM06_3mon (ppm-hrs) - sum of hourly ozone conc.≥0.06 ppm (60 ppb) over 3 months (~ growing season), i.e., cumulative ozone dose
NADP information represents 6-yr average of annual values from 1995-2000
NADP deposition (kg/ha/yr): estimate of pollutants deposited to ecosystem by precipitation (NADP-National Atmospheric Deposition Program)
NADP Total S - sulfur from sulfate deposited by precipitation
NADP Total N - inorganic nitrogen (ammonium plus nitrate) deposited by precipitation
Visibility IMPROVE information represents 5-yr average of annual values from 1995-1999
bextClear - measure of light scattering and absorption, i.e., extinction, by particles in the air on an average clear day
bextHazy - measure of light scattering and absorption, i.e., extinction, by particles in the air on an average hazy day

Air Quality Related Values in the CHDN

Air quality related values (AQRVs) are resources that may be adversely affected by a change in air quality and may include visibility or a specific scenic, cultural, physical, biological, ecological, or recreational resource. Table 3 summarizes AQRVs for CHDN park units.

Table 3. Air quality related values of Chihuahuan Desert Network parks. AQRVs are designated with an X. "Unknown" indicates there is not enough park-specific information available to determine if the resource is an AQRV.

Park	Visibility[1]	Vegetation[2]	Surface Waters[3]	Soils[4]	Fish and Wildlife[5]	Night Skies[6]
Amistad NRA	X	X	No	Some soils may be sensitive to eutrophication	Unknown	X
Big Bend NP	X	X	Some tinajas may be sensitive to eutrophication or acidification	Some soils may be sensitive to eutrophication	Unknown	X
Carlsbad Caverns NP	X	X	No	Some soils may be sensitive to eutrophication	Unknown	X
Fort Davis NHS	X	X	No	Some soils may be sensitive to eutrophication	Unknown	X
Guadalupe Mountains NP	X	X	No	Some soils may be sensitive to eutrophication	Unknown	X
Rio Grande WSR	X	No	No	Some soils may be sensitive to eutrophication	X	X
White Sands NM	X	X	No	Some soils may be sensitive to eutrophication	Unknown	X

[1]The NPS has identified visibility as a sensitive AQRV in every unit of the National Park System.
[2]Ozone-sensitive plant species have been identified in the park (http://www2.nature.nps.gov/air/Pubs/ozonerisk.htm and updated at http://science.nature.nps.gov/im/apps/npspp/).
[3]Surface waters in the park are susceptible to acidification or eutrophication from atmospheric deposition of hydrogen ions, nitrogen and/or sulfur.
[4] Soils in the park are susceptible to acidification or eutrophication from atmospheric deposition of hydrogen ions, nitrogen and/or sulfur.
[5]Fish and/or wildlife collected in or near the park have elevated concentrations of mercury and/or other toxic pollutants (e.g., chlordane, PCBs).
[6]Dark night skies, which can be degraded by air pollution, possess value as a scenic, natural, and scientific resources

Wet Deposition Monitoring of Atmospheric Pollutants

Wet deposition in monitored at Big Bend NP and Guadalupe Mountains NP. Estimates of wet deposition for park units are available from Air Atlas. Figure 2 shows locations of NADP/NTN wet deposition samplers in or near CHDN units. Table 1 lists the site identification codes and locations. NADP/NTN collects data on both pollutant deposition (in kilograms per hectare per year – kg per ha per yr) and pollutant concentration (in microequivalents per liter – µeq per L). Deposition measurements are useful because they give an indication of the total annual pollutant loading at the site. However, deposition varies with the amount of annual precipitation. Concentration measurements are independent of precipitation amount; therefore, concentration provides a better indication of whether ambient pollutant levels are increasing or decreasing over time, despite rainfall fluctuations. In general, wet deposition and concentration of sulfate, nitrate, and ammonium are low in the southwestern U.S. relative to the Midwest and East. Pollutant deposition in the CHDN is consistent with this pattern. A trend analysis of 1994-2003 data indicates that sulfate concentrations are decreasing at many sites in the West; however, nitrate and ammonium concentrations are increasing at many sites (Appendix A, figures A.1-A.3).

Dry Deposition Monitoring of Atmospheric Pollutants

Estimates of dry deposition for park units are available from Air Atlas. There is only one dry deposition CASTNet sampler in the CHDN (figure 2, table 1), located in Big Bend NP.

Total Atmospheric Deposition

When assessing ecosystem impacts from atmospheric deposition it is desirable to have estimates of total deposition, that is, wet plus dry deposition plus cloud/fog deposition. Cloud and fog deposition are not likely to be significant in the CHDN; total deposition can be estimated from wet plus dry deposition. For example, at Big Bend NP, total nitrogen deposition from 1999-2001 was approximately 2.5 kg per ha per yr; total sulfur deposition was approximately 2 kg per ha per yr (CASTNet at http://www.epa.gov/castnet/sites/bbe401.html).

For sites with only wet deposition data (monitored or estimated), total deposition can be estimated by assuming that dry deposition rates are approximately equal to wet deposition rates and therefore,

Total deposition = 2 X wet deposition

For example, the Air Atlas estimates of wet inorganic nitrogen deposition (nitrate plus ammonium) for 1995-1999 range from 1.38-2.15 kg per ha per year in the CHDN units, so that:

Total inorganic N deposition = 2.8- 4.3 kg per ha per year

Air Atlas estimates of wet sulfur deposition for 1995-1999 range from approximately 1.09-1.88 kg per ha per year in the CHDN units, so that:

Total S deposition = 2.2-3.8 kg per ha per year

These estimates suggest that deposition of both nitrogen and sulfur are elevated above natural levels of deposition. Estimates of natural deposition for either sulfur or nitrogen in the West are approximately 0.2 kg per ha per yr.

Atmospheric Deposition Effects to Ecosystems
Atmospheric deposition of nitrogen and sulfur compounds can affect water quality, soils, and vegetation. Both nitrogen and sulfur emissions can form acidic compounds (e.g., nitric or sulfuric acid); when deposited into ecosystems with low buffering capacity, acidification of waters or soils can occur. Research in Big Bend NP has found a rapid, major decrease in soil pH in Big Bend grasslands.

Deposition of nitrogen compounds can also have a fertilization effect on waters and soils. In some areas of the country, elevated nitrogen deposition has been shown to alter soil nutrient cycling and vegetation species composition. Arid ecosystems, typical of CHDN ecosystems, are often nitrogen-limited. Over time, excess nitrogen deposition may cause native plants that have adapted to nitrogen-poor conditions to be out-competed and replaced by nitrogen-loving nonnative grasses and other exotic species. In addition to changes in species composition, there may be increases in productivity, resulting in increased biomass (i.e., fuel loading) and fire frequency. NPS Air Resources Division has funded a study, initiated in 2003, to assess the impacts of atmospheric nitrogen deposition and climate change on microbial and soil nitrogen dynamics within the sotol-grasslands and high elevation oak-pine forests of the park. Initial results indicate that increased nitrogen alters soil functions, including carbon and organic nitrogen use.

Ground-level Ozone Monitoring
NPS monitors ozone in Big Bend NP and Chamizal NM; State and local air quality agencies also operate a number of ozone monitors near CHDN park units (figure 2). Estimates of ozone peak concentrations and exposure metrics for CHDN park units without on-site monitoring can be obtained from AirAtlas. Data from these monitors has been used by the States and EPA to determine compliance with the EPA ozone health standard (based on an 8-hr averaging period). Part or all of 474 counties nationwide are designated as nonattainment for either failing to meet the 8-hour ozone standard or for causing a downwind county to fail (Figure 4). There are no nonattainment areas in or near the CHDN units (Note: Compliance cannot be determined by the estimates from Air Atlas; these estimates indicate that ozone concentrations approach or exceed the standard in some of the CHDN units). A trends analysis for 1994-2003 indicates that ozone is increasing in many areas of the West (Appendix A, figure A.4).

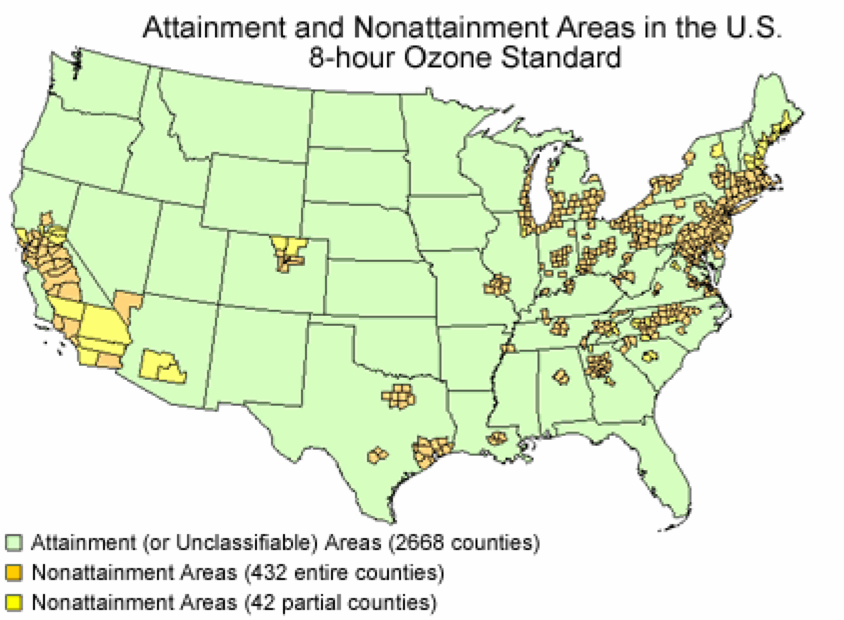

Figure 5. Attainment and nonattainment areas in the U.S. for the 8-hr ozone standard (from http://www.epa.gov/oar/oaqps/glo/designations/index.htm).

Ground-level ozone is produced by the reaction of nitrogen oxides (NO_x) and volatile organic compounds (VOCs) in the presence of sunlight. Ozone is a strong oxidant. Upper-atmospheric ozone (i.e., stratospheric ozone) acts as a protective shield against ultraviolet radiation; ground-level ozone (i.e., tropospheric ozone) is harmful to human health and vegetation. Although ground-level ozone is principally an urban problem, it and its precursor emissions can travel long distances, resulting in elevated ozone levels in national park units. Power plants, automobiles, and factories are the main anthropogenic emitters of nitrogen oxides. Vehicles and industries also emit VOCs. Natural biogenic VOC emissions are significant in some geographic areas.

Ozone affects human health, causing acute respiratory problems, aggravation of asthma, temporary decreases in lung capacity in some adults, inflammation of lung tissue, and impairment of the body's immune system. Chamber studies have shown ozone effects to birds and other wildlife. However, these effects to birds and wildlife have not been demonstrated in the wild. Effects to vegetation have been widely documented and ozone is one of the most widespread pollutants affecting vegetation in the U.S. Ozone enters plants through leaf stomata and oxidizes plant tissue, causing changes in biochemical and physiological processes. Both visible foliar injury (e.g., stipple and chlorosis) and growth effects (e.g., premature leaf loss, reduced photosynthesis, and reduced leaf, root, and total dry weights) can occur in sensitive plant species. Long-term exposures can result in shifts in species composition, with ozone tolerant species replacing intolerant species.

Research shows that some plants are more sensitive to ozone than humans, and effects to plants occur well below the EPA standard. Ozone causes considerable damage to vegetation throughout the world, including agricultural crops and native plants in natural ecosystems. Ozone effects on natural vegetation have been documented throughout the U.S., particularly in many areas of the East and in California. A relatively small number of national parks have been surveyed for ozone injury;

injury has been documented in Great Smoky Mountains, Shenandoah, Lassen Volcanic, Sequoia/Kings Canyon, and Yosemite National Parks.

Scientists use various metrics to describe ozone exposure to plants, in addition to the 1-hour or 8-hour average concentrations reported by EPA. These metrics, the Sum06 and the W126, are believed to be biologically relevant, as they take into account both peak ozone concentrations and cumulative exposure to ozone. Hourly concentrations from a continuous or portable continuous ozone analyzer are needed to calculate either metric.

Sum06 -- The running 90-day maximum sum of the 0800-2000 hourly ozone concentrations of ozone equal to or greater than 0.06 ppm. The Sum06 is expressed in cumulative ppm-hr. Several thresholds have been developed for Sum06:

Natural Ecosystems	8 - 12 ppm-hr	(foliar injury)
Tree Seedlings	10 - 16 ppm-hr	(1-2% reduction in growth)
Crops	15 - 20 ppm-hr	(10% reduction in 25-35% of crops)

W126 -- A cumulative index of exposure that uses a sigmoidal weighting function to give added significance to higher concentrations of ozone while retaining and giving less weight to mid and lower concentrations. The number of hours over 100 ppb (N100) is also considered in assessing the possible impact of the exposure. The W126 index is in cumulative ppm-hr. Several thresholds have been developed for W126:

	W126	N100
Highly Sensitive Species	5.9 ppm-hr	6
Moderately Sensitive Species	23.8 ppm-hr	51
Low Sensitivity	66.6 ppm-hr	135

In a natural ecosystem, many other factors can ameliorate or magnify the extent of ozone injury at various times and places such as soil moisture, presence of other air pollutants, insects or diseases, and other environmental stresses.

Ozone sensitive and bioindicator plant species have been identified for all of the CHDN units except Rio Grande WSR and lists are available from NPSpecies (https://science1.nature.nps.gov/npspecies/). Species were identified by cross-referencing NPSpecies with sensitive species identified in "Ozone Sensitive Plant Species on National Park Service and U.S. Fish and Wildlife Service Lands" (2003) at http://www2.nature.nps.gov/air/Pubs/BaltFinalReport1.pdf. It is likely that ozone-sensitive species will also be found at Rio Grande WSR when vegetation inventories are completed.

Sensitive species are those that typically exhibit foliar injury at or near ambient ozone concentrations in fumigation chambers and/or are species for which ozone foliar injury symptoms in the field have been documented by more than one observer. Bioindicator species for ozone injury meet all or most of the following criteria: 1) species exhibit foliar symptoms in the field at ambient ozone concentrations that can be easily recognized as ozone injury by subject matter experts, 2) species ozone sensitivity has been confirmed at realistic ozone concentrations in exposure chambers, 3) species are widely distributed regionally, and 4) species are easily identified in the field. Because of these attributes, bioindicator species are recommended for field surveys to assess ozone injury.

NPS completed a risk assessment for parks in 2004, based on the concept that foliar ozone injury on plants is the result of the interaction of the plant, ambient ozone, and the environment. That is, the risk for foliar injury is high if three factors are present: species of plants that are genetically predisposed to ozone, concentrations of ambient ozone that exceed a threshold required for injury, and environmental conditions, primarily soil moisture, that foster gas exchange and the uptake of ozone by the plant.

The assessment used ozone data from 1995-1999 to evaluate risk. Amistad NRA was determined to be at moderate risk from ozone injury; remaining CHDN units, except Rio Grande WSR, were judged to be at low risk (a risk assessment has not been completed for Rio Grande WSR). The assessments should be re-evaluated if ozone increases in the area. Updated lists for ozone-sensitive species should be downloaded from NPSpecies. The ozone risk assessments are available at http://www2.nature.nps.gov/air/Pubs/ozonerisk.htm.

Visibility Monitoring

Visibility is monitored at Big Bend NP and Guadalupe Mountains NP. Each park has a fine particle sampler that measures the types and amounts of particles that obscure visibility. Big Bend NP and Guadalupe Mountains NP also have transmissometers that measure light extinction resulting from fine particles of pollution. Big Bend NP has a nephelometer that measures light scattering. Data are available from the Visibility Information Exchange Web System (VIEWS) at http://vista.cira.colostate.edu/views/. Big Bend also has a webcam that records visibility conditions (http://www2.nature.nps.gov/air/WebCams/index.htm). Estimates of visibility conditions for the remaining CHDN units can be obtained from AirAtlas.

Visibility impairment is regional in nature and monitoring indicates that visibility is degraded to some extent throughout the CHDN area. Trend analysis indicates that visibility is improving slightly on the clearest days and worsening on the haziest days in many areas of the Southwest (Appendix A, figures A.5-A.6). States are required to develop plans to make progress towards the national goal of "the prevention of any future, and the remedying of any existing, impairment of visibility in mandatory Class I federal areas which impairment results from manmade air pollution." Regional planning organizations are currently discussing these plans. The regional planning group for the western U.S., including Colorado and New Mexico, is the Western Regional Air Partnership (WRAP), with information at www.wrapair.org. The regional planning group for the central U.S., including Kansas, Oklahoma, and Texas, is the Central States Regional Air Partnership (CENRAP), with information at http://cenrap.org/.

Because of concerns regarding visibility impairment in Big Bend NP, NPS and EPA initiated the Big Bend Regional Aerosol & Visibility Observational Study (BRAVO). A final report issued in 2004 found that sulfate particles from power plants, metal smelters, refineries, and other sources are the single largest contributor to haze at the park. More than half of the sulfate came from the U.S., in particular from the eastern U.S. and Texas. Mexican sources contributed approximately one-third of the sulfate at the park. Information on BRAVO is at http://www2.nature.nps.gov/air/studies/bravo/index.htm.

Toxic Air Pollutant Monitoring (Mercury Deposition Monitoring)
Monitoring of toxic air pollutants, including organic chemicals (e.g., pesticides, herbicides, PCBs, dioxin) and heavy metals, is done by two nationwide networks: the Mercury Deposition Network (MDN), which collects rainfall for mercury analysis at over 60 sites nationwide (http://nadp.sws.uiuc.edu/mdn/), and the National Dioxin Air Monitoring Network (NDAMN -- http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=54811), which analyzes air samples at 32 sites nationwide for dioxins and polychlorinated biphenyls.

MDN has one sampler near CHDN units, operated by the U.S. Geological Survey near Caballo, New Mexico. Concentrations of total mercury in rain at Caballo are relatively high; however, total annual deposition of mercury is low because rainfall is very low. Coal-burning power plants are major sources of mercury to the atmosphere and, eventually, terrestrial and aquatic ecosystems. Other sources of atmospheric mercury include incinerators, mining activities, and natural sources. Mercury mining occurred historically in the Big Bend area. Bioaccumulation of mercury in fish and wildlife can result in neurological and reproductive effects to wildlife and humans. Fish consumption advisories have been issued for certain reservoirs in Texas and New Mexico (see http://epa.gov/waterscience/fish/states.htm).

NDAMN has a sampler in Big Bend NP. Sources of dioxins and polychlorinated biphenyls include combustion, certain types of chemical manufacturing and processing, chlorine bleaching of pulp and paper, and other industrial processes. Dioxins and polychlorinated biphenyls can cause adverse effects on human development and can be carcinogenic. Concentrations of dioxins and polychlorinated biphenyls at Big Bend NP are typical of other rural sampling sites in NDAMN; in contrast, concentrations at urban sites are much higher.

There is no information available on the effects of mercury, dioxins, and polychlorinated biphenyls on the resources in the CHDN.

Ultraviolet Radiation Monitoring
Ultraviolet radiation was monitored in Big Bend NP as part of the Park Research & Intensive Monitoring of Ecosystems NETwork (PRIMENET). Monitoring was discontinued in 2004. Information on PRIMENET is at http://www.forestry.umt.edu/research/MFCES/programs/primenet/.

Relevant Websites
ARIS at http://www2.nature.nps.gov/air/
NPS AirWeb at http://www2.nature.nps.gov/air/
Air Atlas at http://www2.nature.nps.gov/air/Maps/AirAtlas/index.htm
NADP at http://nadp.sws.uiuc.edu/
MDN at http://nadp.sws.uiuc.edu/mdn/
CASTNet at http://www.epa.gov/castnet/
EPA Ozone (AirData) at http://www.epa.gov/air/data/index.html
NPS Ozone Data at http://www2.nature.nps.gov/air/data/index.htm
IMPROVE at http://vista.cira.colostate.edu/views/
Pollution sources and air quality data at http://www.epa.gov/air/data/index.html

VIEWS at http://vista.cira.colostate.edu/views/

Appendix A: Trends in Ozone, Visibility, and Wet Deposition

1994-2003

(Source: FY 2004 Annual Performance Report: Government Performance and Results Act, Air Resources Division)

Figure A.1

Trends in SO4 Concentrations in Precipitation, 1994-2003

FY2004 Annual Performance Report for NPS Government Performance and Results Act (GPRA)

Air Quality Goal Ia3

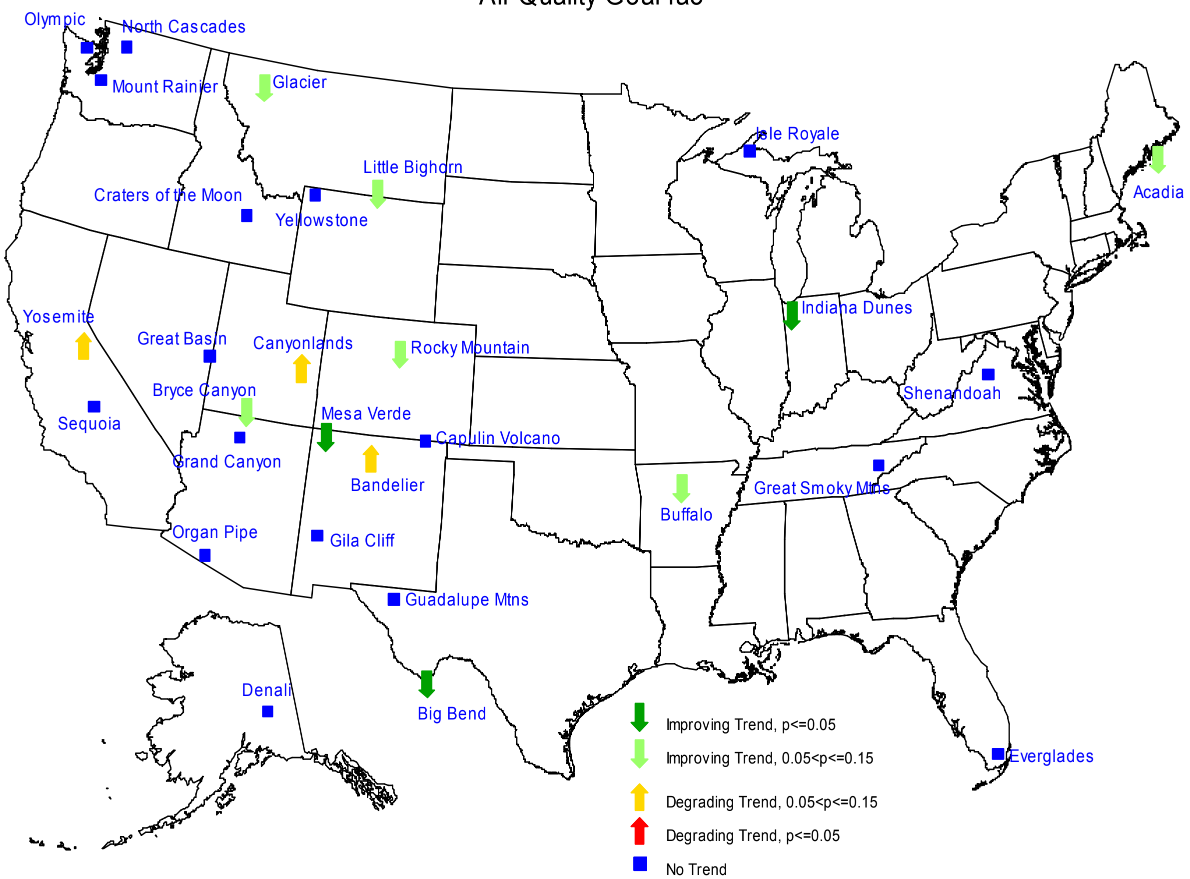

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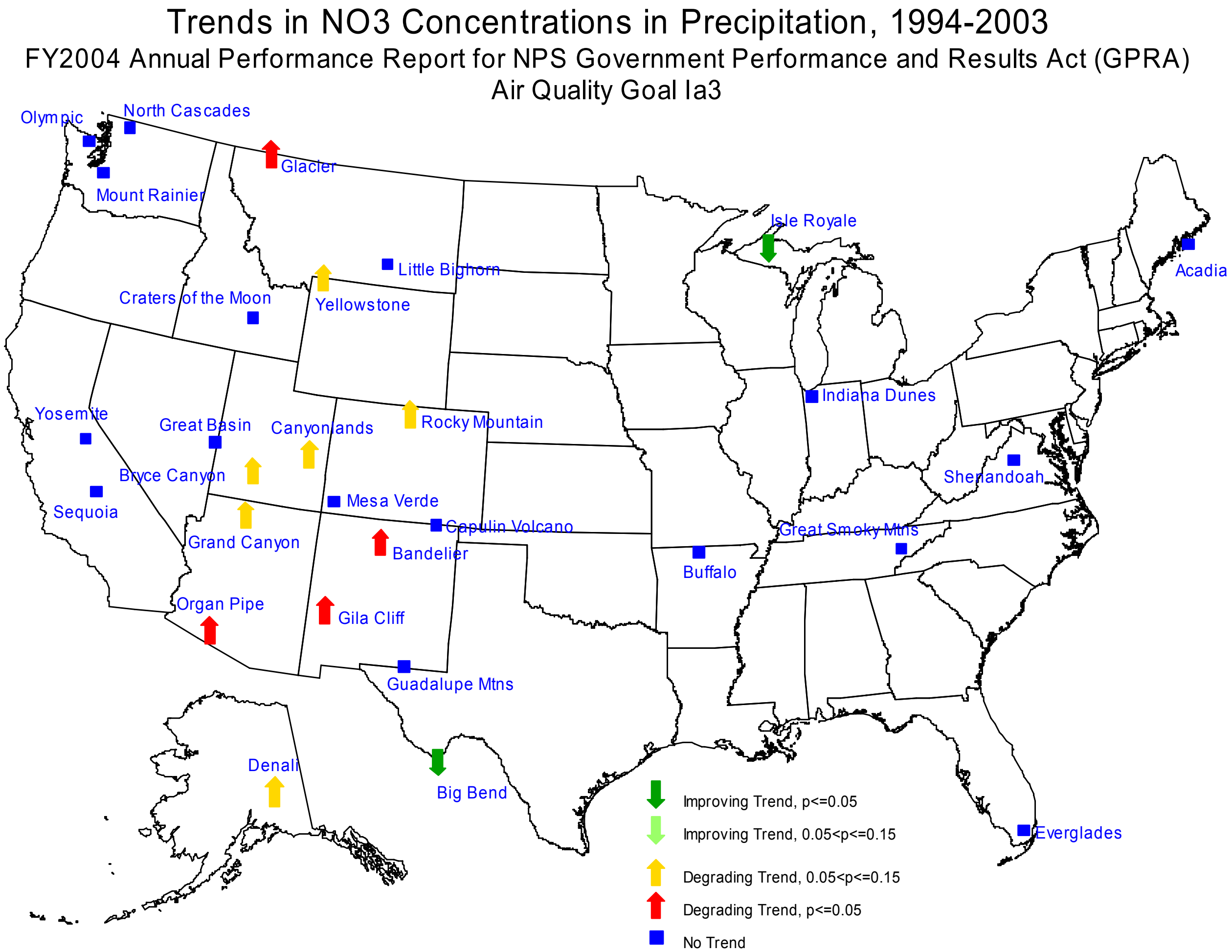
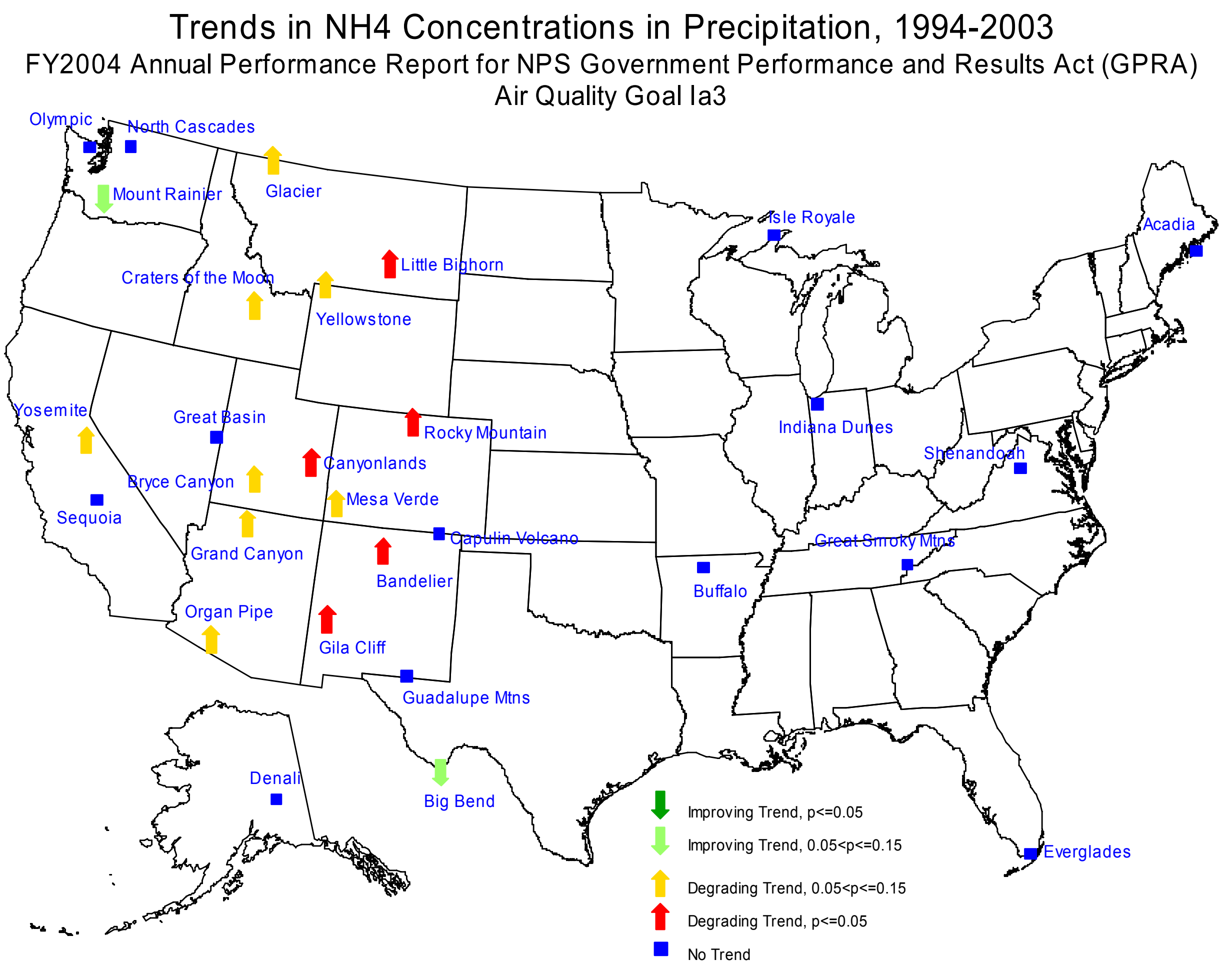
Figure A.2



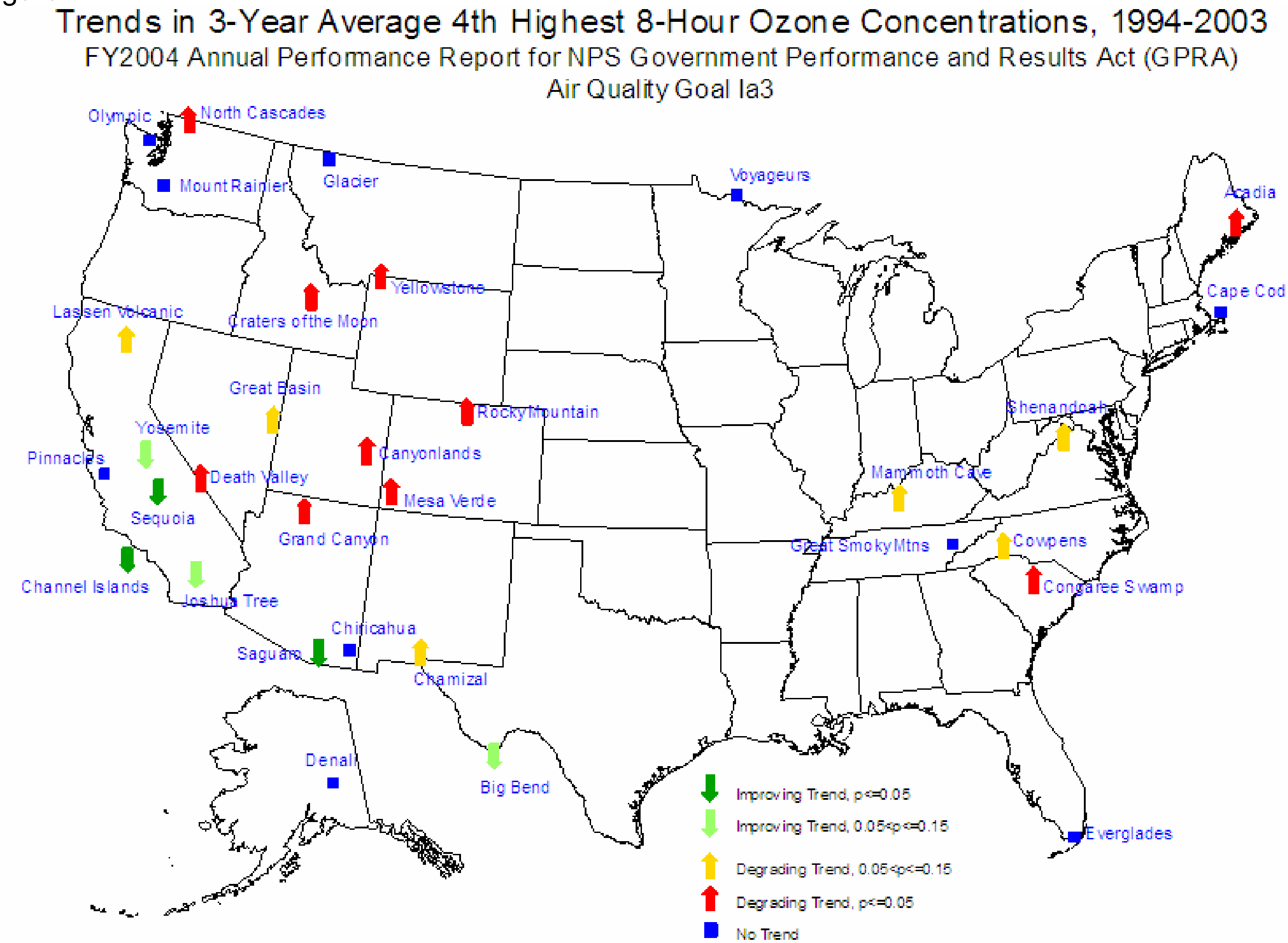
02/03/2005

Figure A.3



02/03/2005

Figure A.4



Trends in 3-Year Average 4th Highest 8-Hour Ozone Concentrations, 1994-2003
FY2004 Annual Performance Report for NPS Government Performance and Results Act (GPRA)
Air Quality Goal Ia3
Olympic
North Cascades
Mount Rainier
Glacier
Voyageurs
Acadia
Yellowstone
Craters of the Moon
Lassen Volcanic
Cape Cod
Great Basin
Rocky Mountain
Shenandoah
Yosemite
Canyonlands
Pinnacles
Death Valley
Mammoth Cave
Mesa Verde
Sequoia
Grand Canyon
Great Smoky Mtns
Cowpens
Channel Islands
Joshua Tree
Congaree Swamp
Chiricahua
Saguaro
Chamizal
Denali
Big Bend
Everglades
Improving Trend, p<=0.05
Improving Trend, 0.05<p<=0.15
Degrading Trend, 0.05<p<=0.15
Degrading Trend, p<=0.05
No Trend

Figure A.5

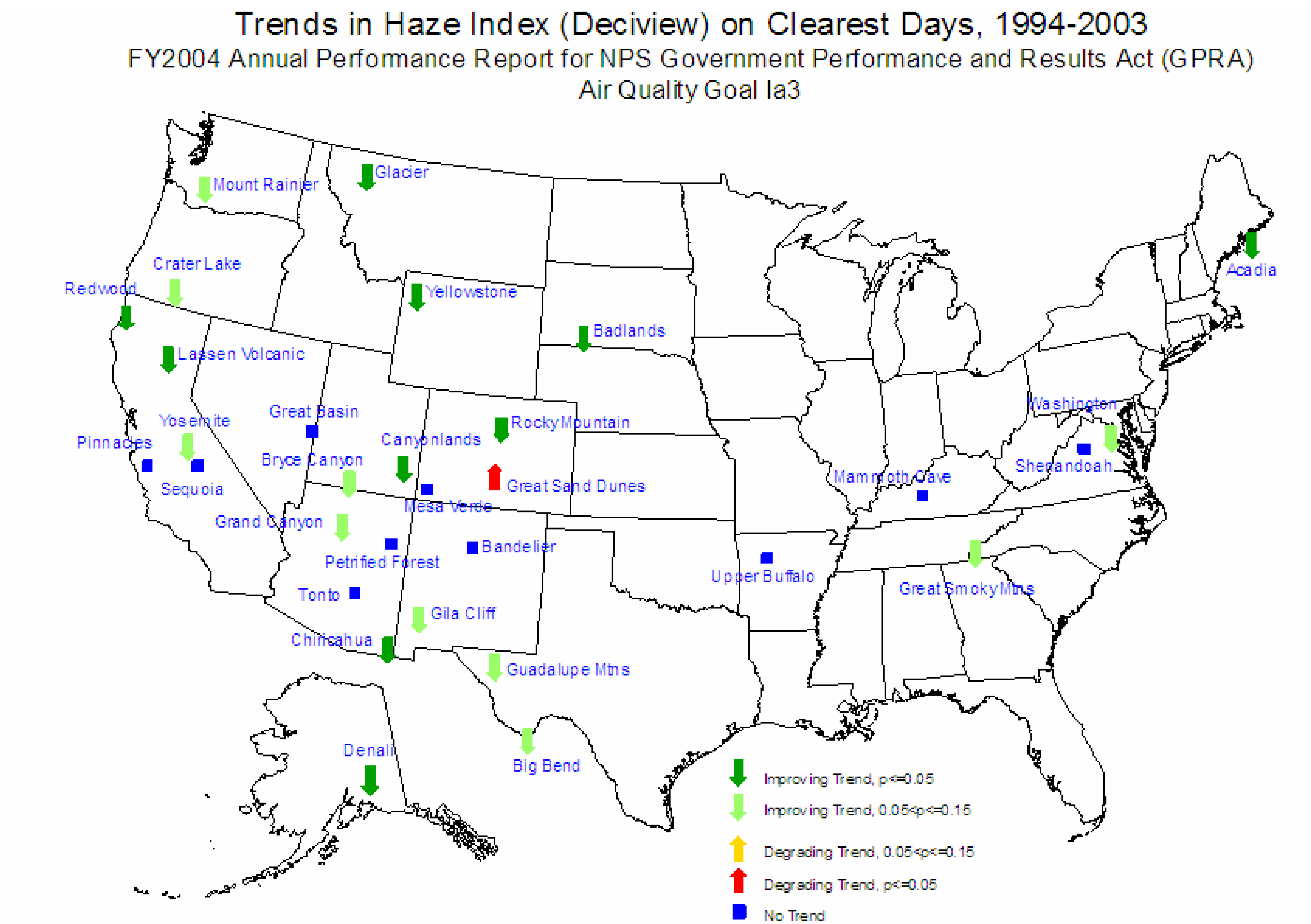
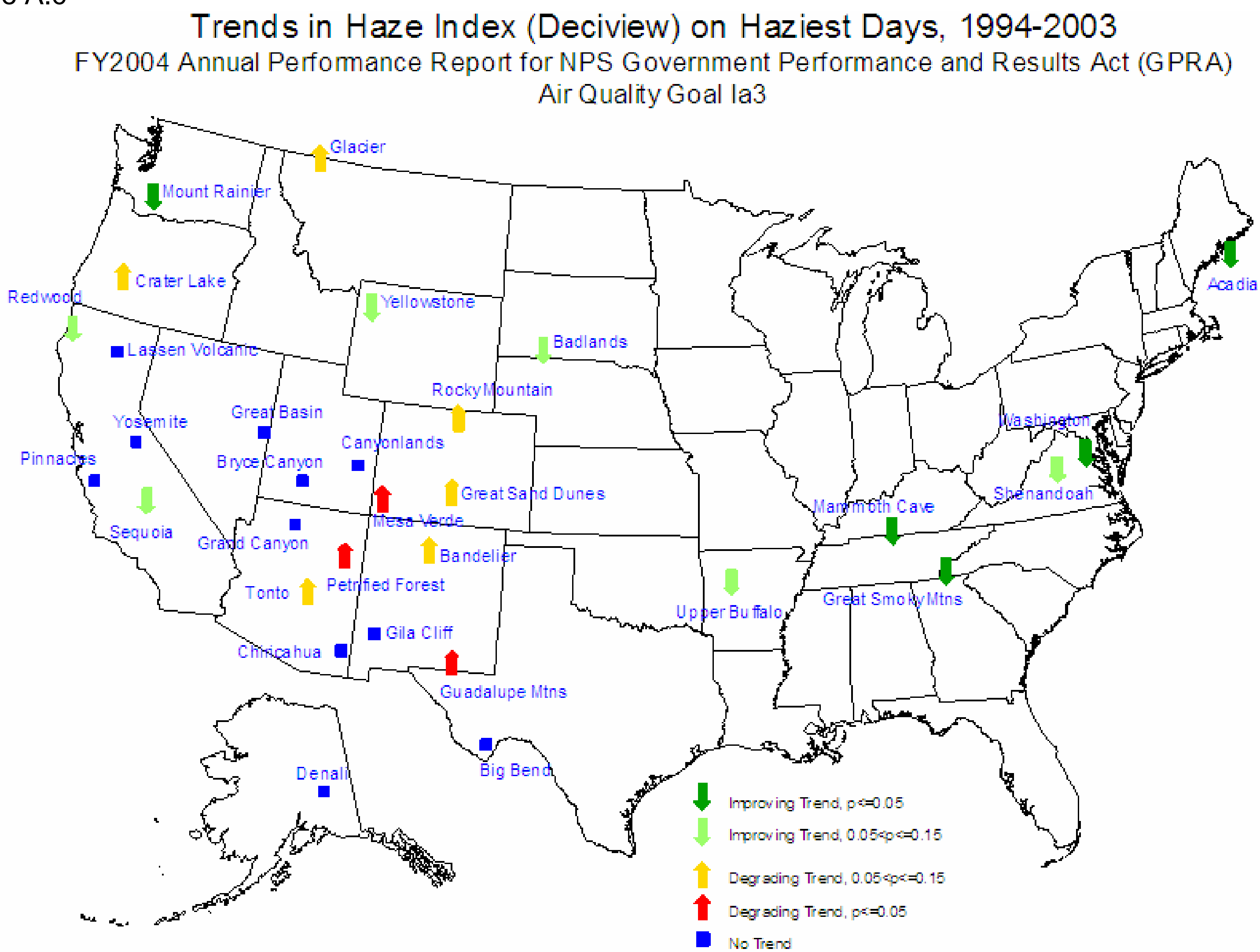

Trends in Haze Index (Deciview) on Clearest Days, 1994-2003
FY2004 Annual Performance Report for NPS Government Performance and Results Act (GPRA)
Air Quality Goal Ia3
Mount Rainier
Glacier
Crater Lake
Redwood
Yellowstone
Acadia
Badlands
Lassen Volcanic
Great Basin
Yosemite
Pinnacles
Canyonlands
Rocky Mountain
Washington
Bryce Canyon
Sequoia
Great Sand Dunes
Mammoth Cave
Shenandoah
Mesa Verde
Grand Canyon
Bandelier
Petrified Forest
Upper Buffalo
Great Smoky Mtns
Tonto
Gila Cliff
Chiricahua
Guadalupe Mtns
Denali
Big Bend
Improving Trend, p<=0.05
Improving Trend, 0.05<p<=0.15
Degrading Trend, 0.05<p<=0.15
Degrading Trend, p<=0.05
No Trend

Figure A.6


Trends in Haze Index (Deciview) on Haziest Days, 1994-2003
FY2004 Annual Performance Report for NPS Government Performance and Results Act (GPRA)
Air Quality Goal Ia3
Glacier
Mount Rainier
Crater Lake
Redwood
Yellowstone
Lassen Volcanic
Badlands
Rocky Mountain
Yosemite
Great Basin
Canyonlands
Pinnacles
Bryce Canyon
Great Sand Dunes
Mesa Verde
Sequoia
Grand Canyon
Bandelier
Petrified Forest
Tonto
Gila Cliff
Chiricahua
Guadalupe Mtns
Big Bend
Denali
Acadia
Washington
Shenandoah
Mammoth Cave
Great Smoky Mtns
Upper Buffalo
Improving Trend, p<=0.05
Improving Trend, 0.05<p<=0.15
Degrading Trend, 0.05<p<=0.15
Degrading Trend, p<=0.05
No Trend